Province of British Columbia
Ministry of Agriculture and Food
Government of Canada
Gouvernement du Canada
Agriculture Canada

ALTERNATE CROPS FOR BRITISH COLUMBIA GREENHOUSES

Project Number 271322

Under

CANADA-BRITISH COLUMBIA SUBSIDIARY AGREEMENT

ON AGRICULTURE AND RURAL DEVELOPMENT

Prepared by:

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Suite 427 Rogers Building
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DECEMBER 1984

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The responsibility for the report as written and all conclusions reached herein, is the consultants' alone, and does not necessarily reflect the opinions of those who assisted during the course of this investigation and the Federal and Provincial governments which funded the study. The consultants acknowledge with gratitude the assistance provided by numerous individuals throughout the course of the study.

EXECUTIVE SUMMARY

PURPOSE

The purpose of the study is to examine the marketing opportunities for alternative crops which could be produced in B.C. greenhouses. The scope of the study also includes a preliminary analysis of the economic viability of the alternative crops which have market potential.

METHOD OF STUDY

In total, we evaluated the market potential for eight crops, including green beans, Chinese vegetables, green onions, fancy lettuce, fancy peppers, radishes, spinach and zucchini. To determine the current size of the market and the changes in the consumption of these crops in Western Canada, we have examined the available wholesale unload statistics for the last five years. To identify the marketing opportunities for each commodity, we have undertaken an extensive market research program consisting of 26 in-depth telephone and personal interviews with major wholesalers in B.C. and the Prairie provinces, as well as representatives of provincial and federal government agriculture departments.

To determine the likely yields and production costs for each crop, we have conducted over 12 interviews with greenhouse specialists and greenhouse producers. Based on the marketing and production information obtained, we undertook a preliminary asessment of the economic viability of producing each crop either as a supplemental crop to be produced in the off season or as a commodity with market potential for year round production. The costs used in the study, therefore, are estimates only and further analysis is required by producers to refine the marketing and product cost information used to evaluate the potential profitability of each crop. Each grower has a specific cost structure which must be accounted for in further analysis. The information provided in this study serves as a guideline to this analysis.

In addition, the scope of the study did not permit a detailed analysis of the prices obtained for each crop over a five year period. This data is needed for a more detailed analysis of the economic viability of each crop.

FINDINGS AND CONCLUSIONS

Based on our market research findings, we have identified five vegetables which could be produced on a year round basis in B.C. to displace the products currently being imported to Western Canada. These crops include Chinese cabbage, green beans, fancy peppers, spinach and zucchini.

Based on the production information available, it appears that green beans and fancy peppers could be produced economically in B.C. greenhouses. In addition, our preliminary analysis indicates that the production of spinach in unheated plastic tunnels could be feasible. As an illustration of the market potential of these three products, if B.C. greenhouse producers were able to achieve a 25% share of the total volume of green beans, spinach and fancy peppers currently imported, about 268,000 square feet of greenhouse space would be required for the production of these vegetables.

We have also identified a number of vegetables which could be produced as a supplementary crop in the winter season by existing greenhouse producers. During this period, local field grown product is not available and the market must rely entirely on imported produce. The vegetables which could be produced as a supplemental crop are green onions, radishes and fancy lettuce. Of these crops, the production of fancy lettuce appears to be the most viable. A total potential acreage of 877,000 square feet would be needed to replace 25% of the total imports of these three products into B.C.

RECOMMENDATIONS

Our recommendations regarding the alternative crops that could be produced in B.C. greenhouses are as follows:

1. Extensive production trials should be undertaken for the more promising crops which have been identified to have market potential.

   The crops to be included in these trials are green beans, fancy peppers, spinach, fancy lettuce, green onions, and radishes. While

some research has already been undertaken, more extensive investigation is required to determine the likely yields and feasibility of producing these crops in B.C. greenhouses and plastic tunnels, especially during the winter months.

2. Based on the results of these production trials, a detailed analysis of the likely production and marketing costs for each vegetable should be undertaken.

   The production cost information should then be used to assess the feasibility of producing the greenhouse crops that have been identified to have market potential.

3. A detailed investigation of the prices obtained by growers for each crop over the last five years should be conducted for the most promising crops. In addition, analysis of the expected future prices should be undertaken for each commodity that appears to have potential.

   This pricing information can then be used in conjunction with refined production cost information to assess the potential profitability of each crop. Growers should undertake a profitability analysis for each crop based on the particular cost structure that exists in their respective operations.

4. The major marketing opportunity that should be pursued is to supply the B.C. market which must import a large proportion of its vegetable requirements. The specific crops that appear promising for for year round production are green beans, fancy peppers, and spinach. The vegetables which could be grown as supplemental crops include fancy lettuce, green onions and radishes.

5. The other market opportunity is to service the Prairie market which relies heavily on imported produce from the United States and Mexico.

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I. METHOD OF STUDY

The purpose of this study is to assess the potential for producing new types of vegetables in B.C. greenhouses. The study includes an investigation of both the market potential and economic viability of producing these alternative crops.

The potential crops investigated include those listed in the initial terms of reference for the study. In addition, we identified a number of other potential crops through discussions with wholesalers and industry representatives. A list of the specific vegetables that were included in our investigation, therefore, are as follows:

1. Green beans
2. Chinese vegetables
3. Green onions
4. Fancy lettuce
5. Fancy peppers
6. Radishes
7. Spinach
8. Zucchini

To determine the consumption levels and the current size of the market for each commodity, we examined the vegetable unload statistics collected by Agriculture Canada for each major city in Western Canada for a five year period. From this information, we also identified the major sources of supply for each crop.

The rationale for using statistics on the volume of wholesale unloads is that more detailed data for each commodity is available than from published import statistics. In addition, the use of wholesale unload data provides information on interprovincial shipments of produce.

Wholesale unloads represent a significant protion of the produce market in each province. As an illustration, wholesale unloads in British Columbia and Alberta account for between 65 to 70% and 80 to 85% of commercial sales, respectively.

The balance of the market consists primarily of sales through small roadside stands and sales in smaller urban centres. Thus, the unload statistics provide a reliable indication of the characteristics of the entire market.

To determine the marketing opportunities for each vegetable, we conducted an extensive market research program consisting of 26 personal and telephone interviews with the major wholesalers in each province in Western Canada. A partial list of the companies contacted is as follows:

British Columbia

Macdonald's Consolidated Ltd.
Vancouver, B.C.

Macdonald's Consolidated Ltd.
Victoria, B.C.

Pacific Produce Ltd.
Vancouver, B.C.

Overwaitea Foods
Langley, B.C.

Woodwards Stores Ltd.
Vancouver, B.C.

Alberta

Macdonald's Consolidated
Edmonton, Alberta

Horne & Pitfield
Edmonton, Alberta

Horne & Pitfield
Calgary, Alberta

Saskatchewan

Macdonald's Consolidated
Regina, Saskatchewan

Macdonald's Consolidated
Saskatoon, Saskatchewan

Scott National Co. Ltd.
Saskatoon, Saskatchewan

The Produce People Inc.
Regina, Saskatchewan

Manitoba

Macdonald's Consolidated
Winnipeg, Manitoba

Scott National Co. Ltd.
Winnipeg, Manitoba

Western Grocers Ltd.
Winnipeg, Manitoba

We also contacted the following representatives of provincial and federal agriculture departments to obtain the available market research information for each vegetable:

Ms. Janet Honey
Chief, Analysis Section
Manitoba Department of Agriculture
Winnipeg, Manitoba

Mr. Glen Lucas
Research Assistant
B.C. Ministry of Agriculture and Food
Surrey, B.C.

Mr. Jeff Moh
Agriculture Canada
Burnaby, B.C.

To identify the likely revenues that could be received in B.C. for each crop, we analyzed the available F.O.B. and wholesale to retail price information for 1983. Wherever possible, we used FOB data. Price information for commodities sold in the Prairie provinces, however, was more limited. As a general rule, we found that a pound of produce in the Prairie Provinces costs wholesalers a $.01 to $.02 per pound more than in B.C. as a result of higher charges to ship from California and Mexico. The scope of the study, however, did not permit a five year analysis of pricing data for each commodity invesitgated.

Based on the wholesale to retail price data obtained form the B.C. Ministry of Agriculture and Food, we estimated the revenues that growers could realize for each crop. To do so, we divided the wholesale to retail price by a factor of 1.20

because the average markup realized by wholesalers is 20%. To test the reasonableness of our calculations we presented the monthly prices estimated for each crop to a major wholesaler in Western Canada. This wholesaler indicated that these estimates reasonably represented the revenues that growers could realize for each vegetable. A more detailed price analysis would be warranted before commercial production of these crops is initiated.

To determine the likely yields and costs of production for each crop, we conducted in-depth interviews with Mr. Brian Mauza, Greenhouse Specialist of the B.C. Ministry of Agriculture and Food and several other greenhouse production specialists including the following:

Mr. Fred Maurer
Agassiz Research Station
Agriculture
Canada Agassiz, B.C.

Mr. Frank Ingratta
Ontario Ministry of Agriculture and Food
Vineland Research Station
Vineland, Ontario

Mr. Mirza Mohuyddin
Alberta Horicultural Research Station
Brooks, Alberta

In addition, we contacted approximately eight B.C. greenhouse producers to obtain the available information regarding the likely production costs and constraints of the vegetables investigated.

As no actual production cost information was available for each crop, we established estimates regarding the heat and light requirements for each crop relative to those required for the production of greenhouse tomatoes and cucumbers. These assumptions were made in concert with Mr. Brian Mauza and included information provided by the growers contacted. A detailed description of the methodology employed to develop production cost estimates is provided in Appendices 1 and 2.

The following eight chapters contain our observations and findings regarding the market potential and likely viability of each crop. The last chapter of the report contains a summary of our findings, conclusions and recommendations regarding the most promising alternative crops that could be produced in greenhouses in B.C.

TABLE 1

WHOLESALE UNLOADS OF BEANS
1979 - 1983
('000 lbs.)

	1983	1982	1981	1980	1979
B.C.	1,683	1,240	1,382	1,443	1,212
Prairie Provinces	1,040	867	773	750	615
Western Canada	2,723	2,107	2,155	2,193	1,827

Source: Annual Unload Report Fresh Fruits and Vegetables
Agriculture Canada, 1979 - 1983

II. GREEN BEANS

Our observations and findings regarding the marketing opportunities and production constraints of green beans as a potential greenhouse crop are provided in the following sections.

A. MARKET CHARACTERTISTICS

1. The total volume of all types of beans that were sold through wholesalers in 1983 in Western Canada was 2,723,000 pounds. Based on the wholesalers contacted, approximately 95% or 2,587,000 pounds consisted of green beans while the remainder was yellow and waxed beans.

2. As shown in Table 1 the sales of beans increased considerably by a rate of 10.4% from 1979 to 1983. The average growth rate of beans sold in the Prairie provinces was 12.3% which was higher than the growth rate of 8.6% in B.C. over the last four years.

3. The consumption of beans in B.C. is considerably higher than in the Prairie provinces. As shown in Table 1, total volume of beans consumed in B.C. in 1983 was 1,683,000 million pounds or 62% of the total Western Canadian market. The greater consumption is B.C. likely indicates greater consumer awareness of beans which results from having locally grown beans available. In addition, the population in B.C. is fitness and health-conscious, thus increasing the demand for fresh vegetables.

4. As shown in Table 2 imported beans accounted for approximately 86% of all beans consumed in Western Canada in 1983. The major suppliers were California and Mexico which captured 41% and 37% of the total Western Canadian market, respectively.

5. The only domestic producers of beans are located in B.C. and Manitoba. In 1983, B.C. field growers supplied approximately 299,000 pounds or 18% of the B.C. green bean market. Approximately 6,000

TABLE 2

SOURCE OF SUPPLY OF BEANS
IN 1983
('000 lbs.)

	B.C.	Prairie Provinces	Total
Domestic:			
B.C.	299	6	305
Alberta	-	-	-
Saskatchewan	-	-	-
Manitoba	-	81	81
Other	-	-	-
Total	299	87	386
Imports:			
California	681	442	1,123
Florida	7	77	84
Other U.S.	135	25	160
Mexico	561	409	970
Total	1,384	953	2,337
TOTAL	1,683	1,040	2,723

Source: Annual Unload Report Fresh Fruits and Vegetables
Agriculture Canada, 1979 - 1983

pounds of beans were also shipped from B.C. to the Prairie provinces. The volume of beans produced in Manitoba was approximately 81,000 pounds which were sold entirely in Manitoba. As a result, Alberta and Saskatchewan rely almost entirely on beans imported from Mexico and California.

6. As shown in Table 3, B.C field grown beans are supplied to the market primarily between the months of July and October. During this period, they accounted for up to 79% of the total volume of beans sold to the major wholesalers in B.C. in 1983.

7. The major suppliers for the balance of the year to the B.C. market are California and Mexican growers. As shown in Table 3, beans from California were purchased primarily between April to November while Mexican beans dominated the market from December to April.

8. As shown in Table 3, the average price drops significantly during the summer months to a range of $.42 to $.52 per pound when domestic field grown beans are available. For the remainder of the year when only imported products are available, the price of green beans increases to over $1.10 per pound.

B. MARKETING OPPORTUNITIES

Our observations regarding the marketing opportunities for green beans produced in B.C. are as follows:

1. There exists a potential to further increase the sales of green beans in B.C. and the Prairie provinces. The increased demand for green beans is due to a trend towards the greater consumption of fresh vegetables versus canned and frozen products. In addition, consumers appear willing to use a greater variety of vegetables. Based on the wholesalers contacted, the volume of green beans sold in Western Canada is projected to increase by about 8 to 10% over the next three years.

TABLE 3

MONTHLY UNLOADS OF BEANS
IN B.C. IN 1983
('000 lbs.)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
B.C.	-	-	-	-	-	-	44	195	53	7	-	-	299
Other Domestic	-	-	-	-	-	-	-	-	-	-	-	-	-
California	4	-	-	22	49	178	101	23	44	87	163	10	681
Mexico	131	75	155	80	23	-	-	-	-	-	-	97	561
Other Imports	-	-	-	-	7	-	107	28	-	-	-	-	142
	135	75	155	102	79	178	252	246	97	94	163	107	1,683
Avg. Price Per Pound	$ .83	$1.11	$1.04	$ .96	$1.00	$ .71	$ .52	$ .45	$ .42	$ .52	$ .50	$ .73	$ .73

Note: The price for each commodity was calculated by determining the average weekly wholesale price for each month in 1983 and then dividing by 120% as the average mark-up is 20% over the wholesaler's cost.

Sources: BCMA Marketing Branch,
Annual Unload Report Fresh Fruits and Vegetables
Agriculture Canada, 1983

2. The types of beans in greatest demand are the Blue Lake and Blue Kentucky varieties. The volume of French beans consumed, on the other hand, is not a significant portion of the total volume of green beans sold.

3. According to the wholesalers contacted, the quality of beans available in the Western Canadian market from November to March is lower than the beans available during the rest of the year. As a result, the wholesalers are willing to consider a local supplier if a higher quality of product could be provided.

4. Because beans have a very short shelf life, the wholesalers expressed a demand for a smaller package size of beans, preferably weighing about 15 pounds. At the present time, the most common size of containers available from the U.S. and Mexico is between 20 to 30 pounds.

5. The major market opportunity, therefore, is to replace the lower quality beans imported into B.C. from November to March. There also exists potential to supply green beans during the remainder of the year if the quality and price were equal to or better than the imported products.

6. The second marketing opportunity is to supply green beans produced in B.C. to the Prairie provinces, particularly Alberta and Saskatchewan, because these provinces rely almost entirely on imported product through the year.

C. PRODUCTION

Green beans are a "warm" crop requiring temperatures between 70° to 75° F in the daytime for optimum growth. The minimum allowable night temperature is about 50° F.

Green beans require approximately seven to eight weeks from planting to harvest. The harvest period lasts approximately four to five weeks.

Green beans are light sensitive and do not flower under low light conditions. The greenhouse producers that we contacted indicated that the latest possible planting date would be August 15 in order for the plants to flower and to produce a fall crop of beans.

Green beans have not yet been produced on a sustained basis in commercial greenhouses in B.C. However, production trials conducted by the B.C. Ministry of Agriculture and Food indicate that crop yields of 1.5 to 2 pounds per square foot could be obtained from the production of green beans in the summer. Production trials have not yet been undertaken, however, during the balance of the year.

D. ECONOMIC VIABILITY

In order to assess the likely costs to be incurred from green bean production in greenhouses, we have contacted producers who have attempted to grow this product. In addition, we have obtained the available information on production costs from Mr. Brian Mauza of the B.C. Ministry of Agriculture and Food. Based on this information, we have undertaken a preliminary analysis regarding the economic viability of producing green beans in traditional greenhouses and plastic tunnels. The major assumptions that we have used are as follows:

1. Green beans would be produced on a year round basis to meet the identified market opportunities.

2. Revenues are based on the production of four crops per year at an average crop yield of 1.5 pounds per square foot.

3. Since the beans would be produced throughout the year, the revenue obtained would be equivalent to the average yearly price of $0.73 per pound. This price was obtained by suppliers to the Vancouver wholesale market in 1983.

4. The production costs include provision for fixed costs, direct operating costs and marketing expenses.

5. The labour costs are estimated to be about $0.84 per square foot which is equivalent to the labour costs incurred for the production of greenhouse tomatoes.

6. Since the degree of environmental control in plastic tunnels is less, the yield likely to be obtained in plastic tunnels is estimated to be about 75% of the productivity in a traditional greenhouse.

Based on the above assumptions, the likely viability of producing green beans in plastic tunnels and greenhouses is calculated below:

ESTIMATED RETURN TO GROWER
FOR GREEN BEAN PRODUCTION
(PER SQUARE FOOT)

	Greenhouses	Plastic Tunnels
Annual Yield (pounds)	6.0	4.5
Revenue	$ 4.38	$ 3.30
Costs	$ 4.24	$ 3.64
Return to Grower	$ 0.14	$ (0.34)

As shown above, a positive return of $0.14 per square foot could be obtained from the production of green beans in a traditional greenhouse. Due to the lower yields obtained, the return to growers from the production of beans in a plastic tunnel is negative resulting in an estimated loss of $.34 per square foot.

TABLE 4

WHOLESALE UNLOADS OF PEPPERS
1979 - 1983
('000 lbs.)

	1983	1982	1981	1980	1979
B.C.	8,401	8,265	7,555	7,923	6,801
Prairie Provinces	10,760	11,005	10,677	9,550	8,875
Western Canada	19,161	19,270	18,232	17,473	15,676

Source: Annual Unload Report Fresh Fruits and Vegetables
Agriculture Canada, 1979 - 1983

III. FANCY PEPPERS

Our observations and findings regarding the opportunity to produce fancy peppers in B.C. greenhouses are as follows:

A. MARKET CHARACTERISTICS

1. The pepper market consists of both green peppers and fancy peppers. Accurate sales statistics, however, are available only for the overall pepper market which are provided in Table 4. As shown in Table 4, the total volume of peppers sold in Western Canada has been increasing at a rate of about 5% per year over the last four years. Based on the wholesalers contacted, the consumption of fancy peppers has been increasing at a faster rate than green peppers.

2. Based on available import statistics and interviews with wholesalers, we have developed an estimate of the size of the fancy pepper market in Western Canada which is provided in Table 5. As indicated, the total volume of peppers sold in Western Canada in 1983 is estimated to be approximately 1,388,200 pounds.

3. Approximately 897,200 pounds or 65% of the total amount of fancy peppers sold in Western Canada were imported from the United States. The majority of this product consisted of sweet red bell peppers which originated from California, Florida and Texas.

4. The next largest supplier of fancy peppers was the Netherlands which shipped a total of 308,100 pounds of fancy peppers into Western Canada in 1983. Approximately 50% of this volume consisted of sweet red and yellow peppers while the balance included white, purple, and other coloured sweet peppers.

5. Mexico supplied approximately 164,000 pounds of primarily halopeno peppers to Western Canada in 1983.

TABLE 5

IMPORTS OF FANCY PEPPERS
IN 1983
('000 pounds)

	B.C.	Prairie Provinces	Total
West Germany	0.7	-	0.7
Netherlands	91.0	217.1	308.1
Spain	7.7	1.3	9.0
Taiwan	1.7	1.8	3.5
Fiji	3.5	-	3.5
Chile	2.0	-	2.0
Mexico[1]	93.9	70.3	164.2
United States	431.4	465.8	897.2
TOTAL	631.9	756.3	1,388.2

[1]Estimated

Sources: External Trade Division, Statistics Canada and discussions with wholesalers.

6. The fancy peppers available from the Netherlands are produced in greenhouses while the peppers imported from the U.S. and Mexico are field grown.

7. Only a minimal volume of fancy peppers are currently produced by domestic field growers in B.C. and Manitoba. As shown in Table 6, domestic pepper production accounted for only 2% of the total Western Canadian market in 1983. Based on the wholesalers contacted, the majority of the domestic production consists of green rather than fancy peppers.

8. Domestic field grown fancy peppers are only available from July to September. Fancy peppers from the Netherlands, U.S., and Mexico, however, are available throughout the year.

9. Based on the information available, red and hot peppers imported from Mexico and California can be purchased for about .50¢ per pound in the fall months. As a comparison, peppers imported from the Netherlands range in price from $2.00 to $3.00 per pound. Because the peppers from the Netherlands come in a range of unusual colours, they are perceived by the consumer to be an exotic and novelty item. The multicoloured fancy peppers from the Netherlands are also desired because they can be used to enhance the presentation of salads and other dishes. As a result, they are able to command a considerable premium in price over the fancy red peppers imported from the United States and Mexico.

TABLE 6

SOURCE OF SUPPLY OF PEPPERS

IN 1983

('000 lbs.)

	B.C.	Prairie Provinces	Total
Domestic:			
B.C.	17	-	17
Alberta	-	-	-
Saskatchewan	-	-	-
Manitoba	-	273	273
Other	-	153	153
Total	17	426	443
Imports:			
California	3,375	3,866	7,241
Florida	3,005	3,718	6,723
Texas	1,087	1,424	2,511
Other	917	1,326	2,243
Total	8,384	10,334	18,718
TOTAL	8,401	10,760	19,161

Source: Annual Unload Report Fresh Fruits and Vegetables
Agriculture Canada, 1979 - 1983

B. MARKETING OPPORTUNITIES

Our observations regarding the market potential for fancy peppers are as follows:

1. Based on the wholesalers contacted, the demand for fancy peppers is likely to increase at an average rate of about 10% per year over the next three years.

2. While the wholesalers contacted were satisified with the fancy peppers currently available, they expressed an interest in securing a local source of supply for the multicoloured peppers currently imported from the Netherlands. This product is in greatest demand between April and November.

3. The major opportunity, therefore, is for B.C. greenhouse growers to produce multicoloured fancy peppers to replace those being imported into Western Canada from the Netherlands.

4. The competition, however, to supply multicoloured peppers is likely to increase. There are indications that greenhouse growers in California and other provinces in Canada are considering the production of this product for the Western Canadian market. As a result, the increased number of suppliers could reduce the market price of multicoloured peppers.

C. PRODUCTION

Peppers are considered to be a warm crop and are self-pollinating. Maximum fruit development occurs at night time temperatures of 60° F. to 70° F. and day time temperatures not greater than 80° F.

Depending on the variety of peppers grown, the time from seeding to first harvest can range from 70 to 100 days. The harvest period can extend for up to seven months. Regular harvesting is necessary to stimulate contiunous fruit production. According to the producers contacted, a crop of peppers can yield up to four pounds per square foot.

A commercial greenhouse grower in Ontario has recently undertaken production trials of fancy peppers. The initial results indicate that the plants require heat directed to their roots for optimum production. As a result, it is likely that fancy peppers would best be produced in traditional greenhouses rather than plastic tunnels.

D. ECONOMIC VIABILITY

The major assumptions that we have used to assess the feasibility of producing fancy peppers in greenhouses are as follows:

1. Due to the greater environmental control (light and heat) in greenhouses, we have assumed that production would be undertaken in a traditional greenhouse.

2. The crop would be planted in February. The harvest season would commence in May and extend to November. As a result, we have assumed that only one crop per year would be obtained.

3. The annual yield per square foot would be about four pounds.

4. The price received by the grower would be about $1.00 per pound. This price reflects the likely increase in competition in the multicoloured fancy pepper market resulting from the entry of both U.S. and Canadian suppliers.

5. The labour requirements are estimated to be about one half of the labour required for greenhouse tomato production.

6. The total costs per square are estimated to be about $3.70 per year.

Based on the above assumptions, we have determined the estimated return to the grower from the production of fancy peppers. The detailed costs and assumptions used to assess the economic viability of fancy pepper production are provided in Appendices 1 and 2 while a summary of our results is provided below:

RETURN TO GROWER
FOR FANCY PEPPERS
(PER SQUARE FOOT)

Yield (pounds)	4
Revenue	$4.00
Cost	$3.70
Return to Grower	$ .30

Based on the available information, therefore, the production of fancy peppers appears to have potential for generating a positive net return to the grower of $.30 per square foot.

TABLE 7

WHOLESALE UNLOADS OF CHINESE VEGETABLES AND CHINESE CABBAGE 1979 TO 1983 ('000 lbs.)

	1983	1982	1981	1980	1979
B.C.	5,590	5,583	5,917	6,348	5,565
Prairie Province	6,197	6,134	5,793	5,109	Data not available
Western Canada	11,787	11,717	11,710	11,457	

Source: Annual Unload Report Fresh Fruits and Vegetables
Agriculture Canada, 1979 - 1983

IV. CHINESE VEGETABLES

Our observations and findings regarding the marketing opportunities and production constraints of Chinese vegetables as a potential greenhouse crop are provided in the following paragraphs.

A. MARKET CHARACTERISTICS

1. The total volume of Chinese vegetables sold through wholesalers in Western Canada in 1983 was 11,787,000 pounds. The two major Chinese vegetables are Chinese cabbage (sui choy) and bok choy which accounted for approximately 6,982,000 pounds and 1,922,000 pounds, respectively. The balance of sales consisted of other Chinese vegetables such as gai lan, bitter melon, giant radishes (lo bok), etc.

2. As shown in Table 7 the demand for Chinese vegetables in B.C. has remained stable over the last four years. The volume of Chinese vegetables sold in the Prairie provinces, however, has increased by an average rate of 6.6% since 1980.

3. Due to the higher concentration of Chinese in B.C. as compared to the Prairie provinces, the consumption of Chinese vegetables in B.C. accounted for 47% of the total Western Canadian market in 1983.

4. California supplied about 85% of the total volume of Chinese cabbage consumed in Western Canada in 1983. As a comparison, domestic field producers supplied only about 10% of the total volume of Chinese cabbage sold in the Western Canadian market.

5. B.C. field growers, however, were the major supplier of Chinese vegetables other than Chinese cabbage to the B.C. market in 1983. As shown in Table 8, B.C. growers supplied a total of 2,246,000 pounds or 84% of the total market for other types of Chinese vegetables such as bok choy in 1983. The major supplier of these other types of Chinese vegetables to the Prairies, however, was California which shipped a total of 1,882,000 pounds or 88% of the

TABLE 8

SOURCE OF SUPPLY OF CHINESE VEGETABLES
IN 1983
('000 lbs.)

	Chinese Cabbage			Other Chinese Vegetables		
	B.C.	Prairie Provinces	Total	B.C.	Prairie Provinces	Total
Domestic:						
B.C.	9	301	310	2,246	129	2,375
Alberta	-	-	-	-	-	-
Saskatchewan	-	-	-	-	-	-
Manitoba	-	-	-	-	-	-
Other	-	410	410	-	108	108
Total	9	711	720	2,246	237	2,483
Imports:						
California	2,625	3,286	5,911	425	1,882	2,307
Mexico	159	19	178	-	-	-
Other	125	48	173	1	14	15
Total	2,909	3,353	6,262	426	1,896	2,322
TOTAL	2,918	4,064	6,982	2,672	2,133	4,805

Source: Annual Unload Report Fresh Fruits and Vegetables
Agriculture Canada, 1979 - 1983

volume sold in the Prairie wholesale market. B.C. field producers of other Chinese vegetables also supplied approximately 129,000 pounds of Chinese vegetables to the Prairies which accounted for 6% of the total market.

6. As shown in Table 9, B.C. field grown Chinese cabbage is available only in September, while imported product must be purchased for the balance of the year. The season for other field grown Chinese vegetables in B.C., however, is considerably longer, extending from May to January. As a result, the majority of Chinese vegetables are imported primarily between February and June.

7. The price obtained for the two major Chinese vegetables, Chinese cabbage and bok choy, are very similar. As shown in Table 9, the price of these products increased substantially to a peak of $0.56 per pound in April, 1983, when only imported product was available.

B. MARKETING OPPORTUNITIES

The marketing opportunities for producing Chinese vegetables in B.C. greenhouses are as follows:

1. The demand for Chinese vegetables in B.C. is not likely to increase substantially over the next three years. The consumption of Chinese vegetables in the Prairie provinces, however, is likely to continue to increase at a rate of 4% to 5% per year. Because there is a sizeable Oriental population in B.C., consumers in B.C. are already familair with Chinese vegetables whereas this awareness is developing in other provinces as a result of interest in experimenting with different kinds of cooking and ethnic food.

2. Bok choy and Chinese cabbage will likely continue to be the two most popular Chinese vegetables as they are the most frequently used vegetables in Chinese dishes.

TABLE 9

MONTHLY UNLOADS OF CHINESE VEGETABLES IN B.C. IN 983

('000 lbs.)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
Chinese Vegetables													
B.C.	2	-	-	-	89	388	270	422	388	415	319	13	2,246
Other Domestic	-	-	-	-	-	-	-	-	-	-	-	-	-
California	25	98	51	51	59	66	51	-	-	4	5	15	425
Other Imports	-	1	-	-	-	-	-	-	-	-	-	-	1
	27	99	51	51	148	394	321	422	388	419	321	28	2,672
Avg. Price Per Pound	$ .35	$ .29	$ .41	$ .56	$ .56	$ .26	$ .21	$ .21	$ .21	$ .16	$ .18	$ .24	$ .27
Chinese Cabbage													
B.C.	-	-	-	-	-	-	-	-	9	-	-	-	9
Other Domestic	-	-	-	-	-	-	-	-	-	-	-	-	-
California	658	696	356	237	168	53	29	22	-	-	60	346	2,625
Other Imports	4	6	112	131	15	-	16	-	-	-	-	-	284
	662	702	468	368	183	53	45	22	9	-	60	346	2,918

Sources: BCMA Marketing Branch
Annual Unload Report Fresh Fruits and Vegetables
Agriculture Canada 1983

3. The wholesalers contacted appear satisfied with the quality and consistency of the present sources of supply of Chinese vegetables. However, they indicated that they would be willing to purchase greenhouse produced Chinese vegetables when domestic product is not available.

4. The major market opportunity, therefore, is for greenhouse growers to supply Chinese cabbage to B.C. and the Prairies on a year round basis as domestic product is available for only about one month during the year.

5. The second marketing opportunity is to supply other Chinese vegetables such as bok choy, giant radishes, etc., to the B.C. and Prairie markets from February to April when domestic field grown product is not available.

C. PRODUCTION

Chinese cabbage is a "cool" crop which will tolerate mild frosts. As a result, it would be suitable for production in unheated plastic tunnels. Chinese cabbage is highly susceptible, however, to loss from tip burn and other culturing problems such as excessive humidity.

The length of time from planting to harvest of Chinese cabbage is about six weeks. According to Mr. Brian Mauza, the average yield per crop of Chinese cabbage is likely to be about 2 pounds per square foot and up to five crops per year could be produced.

The production of Chinese cabbage has been successfully undertaken in unheated plastic tunnels at the Agriculture Canada Research Station in Agassiz. However, the growing times required are longer than in conventional greenhouses. In addition, the quality was reduced due to the lack of sufficient humidity controls in the plastic tunnels.

Attempts at the Aggasiz Research Station indicate that there is potential for the production of giant radishes. Production trials undertaken at the Brooks

Horticultural Research Station also indicate that bitter melons could be produced successfully. However, the information on the likely yields and production costs of other Chinese vegetables is too limited to undertake an analysis of the viability of greenhouse production of these crops.

D. ECONOMIC VIABILITY

Based on the available information from research production trials and interviews with growers who have attempted Chinese vegetables, we have undertaken a preliminary economic analysis of the viability of producing Chinese cabbage in both plastic tunnels and greenhouses. The major assumptions that we have used are as follows:

1. Production of Chinese cabbage could occur on a year round basis to meet the identified market opportunities.

2. The revenue obtained would be $0.27 per pound which is equivalent to the average amount paid for Chinese cabbage supplied to the Vancouver wholesale market in 1983.

3. Total revenues per square foot in a traditional greenhouse would be $2.36 which is based on production of five crops per year. Due to lower productivity, only four crops per year could likely be obtained in plastic tunnels. As a result, the revenue obtained in plastic tunnels is estimated to be $1.40 per square foot.

4. By allowing for a loss of about thirty percent, the average yield per square foot is estimated to be 1.75 pounds per crop in a traditional greenhouse and 1.30 pounds per square foot in a plastic tunnel.

5. The total production costs per square foot are estimated to be about $2.23 and $3.43 in plastic tunnels and traditional greenhouses, respectively.

Based on the above assumptions, the return to the grower from the production of Chinese cabbage in unheated plastic tunnels and greenhouses is provided below:

ESTIMATED RETURN TO GROWER
FOR CHINESE CABBAGE
(PER SQUARE FOOT)

	Greenhouse	Plastic Tunnel
Annual yield (pounds)	8.75	5.20
Revenue	$ 2.36	$ 1.40
Costs	$ 3.43	$ 2.23
Return to Grower	$ (1.07)	$ (0.83)

As shown above, the production of Chinese cabbage on a year round basis does not appear to be viable in greenhouses or plastic tunnels.

TABLE 10

WHOLESALE UNLOADS OF FANCY LETTUCE
1979 - 1983
('000 pounds)

		1983	1982	1981	1980	1979
B.C.	Leaf	4,108	3,947	4,978	4,826	4,497
	Endive	473	816	528	385	Data not available
	Total	4,581	4,763	5,506	5,213	
Prairies	Leaf	11,121	9,129	8,046	6,875	5,633
	Endive	646	578	616	415	Data not available
	Total	11,767	9,707	8,662	7,290	
Western Canada		16,357	14,470	14,168	12,503	

Source: Annual Unload Report Fresh Fruits and Vegetables, Agriculture Canada, 1979 - 1983

V. FANCY LETTUCE

The following paragraphs describe our observations and findings regarding the marketing opportunities and production constraints of fancy lettuce as an alternative crop for B.C. greenhouses. The fancy types of lettuce that we have investigated include romaine, green leaf, and endive lettuce.

A. MARKET CHARACTERISTICS

1. The quantity of fancy lettuce sold through wholesalers in Western Canada totalled 16,357,000 pounds in 1983. Of this total, 15,229,000 pounds consisted of leaf lettuce, while the remainder of the lettuce sold was endive lettuce. According to the wholesalers interviewed, approximately 48% or 7,309,900 pounds of leaf lettuce consisted of romaine varieties while the balance is primarily green leaf lettuce.

2. As shown in Table 10, sales of fancy lettuce in the Prairies have increased at an average rate of 17% per year since 1980. In B.C., however, the volumes of fancy lettuce sold declined by 4% over that period.

3. The consumption of fancy lettuce in the Prairie provinces, particularly Alberta, is considerably higher than in British Columbia. As an illustration, fancy lettuce accounted for approximately 18% of the entire lettuce market in Alberta while in B.C., fancy lettuce represented only 8% of the market. A key factor likely influencing the difference in consumption patterns is the relatively higher field production of head lettuce in B.C. as compared to Alberta. B.C. consumers can more readily purchase locally grown head lettuce than Albertan consumers. As a result, demand for head lettuce is greater in B.C.

4. As shown in Table 11, imported fancy lettuce accounted for 77% of the total fancy lettuce sold through wholesalers in Western Canada in 1983. California supplied 12,428,000 pounds or almost all of the imported lettuce.

TABLE 11

FANCY LETTUCE
(LEAF AND ENDIVE)
SOURCE OF SUPPLY IN 1983
('000 pounds)

	B.C.	Prairie Provinces	Total
Domestic			
B.C.	3,330	227	3,557
Alberta	-	66	66
Saskatchewan	-	1	1
Manitoba	-	176	176
Other		4	4
Total	3,330	474	3,084
Imports			
California	1,251	11,177	12,428
Other	-	116	116
Total	1,251	11,293	12,544
TOTAL	4,581	11,767	16,348

Source: Annual Unload Report Fresh Fruits and Vegetables, Agriculture Canada, 1983.

5. B.C. field producers dominated the fancy lettuce market in their province. In 1983, they supplied 3,330,000 pounds or 73% of the total fancy lettuce sold to wholesalers in B.C. In addition, they shipped 227,000 pounds to the Prairie provinces.

6. Domestic field grown lettuce accounted for only 4% of the fancy lettuce purchased by wholesalers in the Prairie provinces. As a result, these provinces relied almost exclusively on California as a source for fancy lettuce.

7. As shown in Table 12 domestic field grown fancy lettuce is available in B.C. from May to November. During this period, B.C. field lettuce producers supplied between 73% and 96% of the total lettuce market.

8. As shown in Table 12, the price of endive lettuce in 1983 was highest in the month of February while green leaf and romaine prices were highest in April. During the months when domestic field product was available, the price of these products declined dramatically to approximately $0.29 per head.

B. MARKETING OPPORTUNITIES

Our findings and observations regarding the marketing opportunities for fancy lettuce are outlined below:

1. The wholesalers interviewed indicated that the quality of fancy lettuce imported from California is excellent throughout the year. They would be willing, however, to purchase local greenhouse grown fancy lettuce if it was of comparable quality and price to the product purchased from California.

2. The most immediate marketing opportunity, therefore, is for B.C. greenhouse growers to produce fancy lettuce for the B.C. and Prairie markets during the months from December to April when local field product is not available.

TABLE 12

LEAF LETTUCE
MONTHLY UNLOADS IN B.C.
('000 pounds)
1983

	J	F	M	A	M	J	J	A	S	O	N	D	Total
B.C.	-	-	-	-	239	804	551	634	585	372	30	-	3,215
Other Domestic													
California	76	72	143	160	78	36	33	44	44	44	81	82	893
Other Imports	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	76	72	143	160	317	840	584	678	629	416	111	82	4,108
Avg. Price/Head Leaf	$.45	$.37	$.60	$.83	$.44	$.33	$.32	$.29	$.29	$.29	$.29	$.58	$ .42
Avg. Price/Head Romaine	$.45	$.37	$.45	$.78	$.33	$.32	$.32	$.29	$.29	$.29	$.29	$.62	$ .40

ENDIVE LETTUCE
MONTHLY UNLOADS IN B.C.
('000 pounds)
1983

	J	F	M	A	M	J	J	A	S	O	N	D	Total
B.C.	-	-	-	-	7	30	24	27	14	11	2	-	115
Other Domestic													
California	46	39	44	60	37	14	10	13	11	8	35	41	358
Other Imports	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	46	39	44	60	44	44	34	40	25	19	37	41	473
Avg. Price/Head Endive	$.80	$1.01	$.79	$.50	$.42	$.31	$.32	$.29	$.29	$.29	$.29	$.61	$ .49

Source: Annual Unload Report Fresh Fruits and Vegetables, Agriculture Canada, 1983.

3. The wholesalers in B.C. indicated that the consumption of fancy lettuce in B.C. will not increase substantially over the next three years as consumers still prefer crispy head lettuce. Industry representatives in the Prairies, however, noted that increases in demand for fancy lettuce will also likely moderate to about 8% to 10% per year for the next 3 years.

C. PRODUCTION

Lettuce is a "cool" crop which grows best in environments where the maximum daytime temperature does not exceed 70° F. Production trials undertaken at the Agriculture Canada Research Station in Agassiz, B.C., indicate that there are some varieties of romaine lettuce which could be produced on a year round basis in unheated plastic tunnels. Supplemental heat may be required, however, in extreme cold conditions. According to results published by the Agassiz Research Station, it takes approximately three and a half months for a crop to mature if it is seeded in November.

The attempts to produce green leaf lettuce in unheated plastic tunnels at the Agassiz Research Station did not prove to be successful. As a result, it does not appear that leaf lettuce is suitable for production in plastic tunnels. Leaf lettuce, however, has been grown in greenhouses at the Horticultural Research Station in Brooks, Alberta. The results of these trials suggest that leaf lettuce can be successfully produced in heated greenhouses.

A leaf lettuce crop would require approximately two and a half months from seeding to harvest if the crop was seeded in November. A yield of two heads per square foot could likely be obtained from each crop.

According to information provided by producers, endive yields per square foot would be approximately half that of leaf lettuce or one head per square foot. The period from seeding to harvest would be depend on the variety planted. As an illustration, some types of endive can be harvested 9 weeks after seeding.

D. ECONOMIC VIABILITY

Based on our discussions with greenhouse producers and government horticulturalists, we have performed a preliminary analysis of the incremental returns that could be realized by growers if they produced fancy lettuce during the months when local field grown product is not in season. The major assumptions that we have used are as follows:

1. Romaine lettuce could be produced in unheated plastic tunnels while leaf and endive would be grown in heated greenhouses.

2. Greenhouse producers could raise 2 crops of leaf or endive lettuce during the period between pulling and starting production of their major crops. The yield for a crop of leaf lettuce is projected to be 1.8 heads per square foot while for endive, the yield would be 0.9 heads per square foot. Seeding would be performed November 1 and harvesting would be completed by the end of January. Another crop could be planted in February and harvested in April.

3. Producers using unheated plastic tunnels could raise two crops of romaine lettuce during the months from January to April. The yield per crop would be only 0.9 heads per square foot due to the lower level of environmental control in unheated plastic tunnels. The crop would be harvested in February and April.

4. The incremental costs for greenhouse production would include heating, direct operating costs and marketing expenses. These costs are estimated to total $0.78 per square foot.

5. The incremental costs of unheated plastic tunnel production would include only direct operating and marketing expenses and are estimated to be $0.40 per square foot.

6. The revenues realized by the grower are based on the market price when the crop is harvested. As a result, the average price obtained for leaf lettuce is estimated to be $0.56. The average endive price in

those months is projected to be $0.74, while the price received for romaine is estimated to be $0.53.

Based on the above assumptions, the incremental returns to the grower from the production of fancy lettuce in the off season are provided below:

INCREMENTAL RETURNS TO GROWER
FOR LETTUCE PRODUCTION
PER SQUARE FOOT
(growing period from January to April)

Leaf Lettuce:	
Yield (heads)	3.6
Revenues	$2.01
Costs	0.78
Return	$1.23
Endive:	
Yield (heads)	1.8
Revenues	$1.33
Costs	0.78
Return	$0.55
Romaine:	
Yield (heads)	1.8
Revenues	$ .95
Costs	0.42
Returns	$0.53

As illustrated above, a positive return could be realized by producing all three types of lettuce during the months from December to April. The projected returns are highest for leaf lettuce that would be produced in a traditional greenhouse.

TABLE 13

WHOLESALE UNLOADS OF RADISHES
1979 - 1983
('000 lbs.)

	1983	1982	1980	1981	1979
B.C.	3,202	3,055	3,177	3,085	2,843
Prairie Provinces	4,818	4,528	6,045	5,378	4,810
Total Western Canada	8,020	7,583	9,222	8,463	7,653

Source: Annual Unload Report Fresh Fruits and Vegetables
Agriculture Canada, 1979 - 1983

VI. RADISHES

The subsequent sections contain our findings and observations regarding the marketing opportunities and production constraints of producing radishes in B.C. greenhouses.

A. MARKET CHARACTERISTICS

1. In 1983, a total of 8,020,000 pounds of radishes were sold through wholesalers in Western Canada.

2. As can be seen in Table 13, the demand for radishes grew slowly in B.C. at an average rate of 3% per year over the last four years. Consumption of radishes in the Prairies, however, has remained relatively stable. The overall growth in the consumption of radishes in Western Canada averaged only 1.2% between 1979 and 1983.

3. As shown in Table 14, local B.C. field growers sold 1,616,000 pounds of radishes to B.C. wholesalers which is equivalent to 50% of the total quantity of radishes purchased in 1983. In addition, radishes imported from California accounted for 48% of the total volume of radishes sold in B.C..

4. In 1983, domestic radishes represented only 9% of total radish unloads in the Prairie provinces. Wholesalers in the Prairie provinces imported 4,364,000 pounds or 91% of the total amount of radishes purchased. California supplied 6% of the total radishes sold while Mexico, Florida the and other U.S. states supplied 74% of all the radishes consumed in the Prairie provinces.

5. As shown in Table 15, B.C. field grown radishes are available from April to December. Between June and September, B.C. field grown radishes dominated the market and accounted for between 93% and 97% of the total volume of radishes sold.

TABLE 14

SOURCE OF SUPPLY OF RADISHES IN 1983

('000 lbs.)

	B.C.	Prairie Provinces	Total
Domestic:			
B.C.	1,616	284	1,900
Alberta	-	144	144
Saskatchewan	-	-	-
Manitoba	-	26	26
Other	-	-	-
Total	1,616	454	2,070
Imports:			
California	1,537	1,237	2,774
Florida	37	1,312	1,349
Other U.S.	9	1,680	1,689
Mexico	3	135	138
Total	1,586	4,364	5,950
TOTAL	3,202	4,818	8,020

Source: Annual Unload Report Fresh Fruits and Vegetables
Agriculture Canada, 1979 - 1983

6. As shown in Table 15, the price of radishes in the Vancouver wholesale market in 1983 was highest between December and April when only imported produce was available. During the months when field grown radishes were available, the price decreased to $0.17 per bunch.

B. MARKETING OPPORTUNITIES

Our findings regarding the market opportunities for B.C. radishes are as follows:

1. The wholesalers contacted indicated that the availability of radishes is excellent throughout the year. However, they indicated that the foliage of the radishes currently available is wilted which inhibits sales to the consumers.

2. The wholesalers expressed a willingness to purchase radishes from B.C. greenhouse growers when local field grown product is unavailable. This product would not be able to command a premium price, however, as it is unlikely that the greenhouse product could be differentiated substantially from field grown radishes.

3. Based on our interviews with wholesalers, we estimate that the demand for radishes will not increase substantially in the next 3 years.

4. There exists a marketing opportunity for B.C. greenhouse growers to supply the B.C. and Prairie markets with radishes when field grown radishes are unavailable. This period extends from December to March.

C. PRODUCTION

Radishes require cool conditions of between 65° F. and 70° F. for optimum growth. In Holland, radishes grown in greenhouses can mature in three weeks during the spring and summer but can take up to 10 weeks in the winter when the number of hours of sunshine is low.

TABLE 15

MONTHLY UNLOADS OF RADISHES
IN B.C. IN 1983
('000 lbs.)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
B.C.	-	-	-	44	270	381	277	283	213	135	13	-	1,616
Other Domestic	-	-	-	-	-	-	-	-	-	-	-	-	-
California	217	219	294	226	50	19	10	14	16	69	187	208	1,537
Other Imports	-	4	-	23	-	-	-	3	-	-	5	14	49
	217	223	294	293	328	400	287	300	229	204	205	222	3,202
Avg Price Per Bunch	$ .23	$ .21	$ .19	$ .24	$ .20	$ .19	$ .17	$ .17	$ .17	$ .17	$ .17	$ .21	$ .19

Sources: BCMA Marketing Branch
Annual Unload Report Fresh Fruits and Vegetables
Agriculture Canada 1983

According to information obtained from greenhouse producers and Mr. Brian Mauza of the B.C. Ministry of Agriculture and Food, a crop of radishes can yield up to 1.5 bunches per square foot under greenhouse conditions.

D. ECONOMIC VIABILITY

Based on the information provided by industry representatives, we have performed a preliminary analysis of the potential incremental returns that a greenhouse grower could realize by growing radishes. The major assumptions of this analysis are as follows:

1. Production would be aimed at harvesting in the months from December to March.

2. Production could be undertaken in either a heated greenhouse or heated plastic tunnel.

3. Harvesting would be performed manually.

4. The first crop would be planted November 1 and be ready for harvest by January 1. A second crop could then be planted in January and harvested in March. Thus, a total of 2 crops would be grown.

5. The yield per square foot is estimated to be 1.5 bunches per crop in both greenhouses and heated tunnels.

6. The average revenue received from sale of radishes is estimated to be $0.21 per bunch.

7. The incremental costs incurred would include heating, direct operating and marketing expenses. The heating costs in a single poly plastic tunnel would be approximately 20% higher as the heat loss through a plastic tunnel would be greater than a greenhouse. This heat loss could be reduced by using an air inflated double polyethylene greenhouse. If this type of facility were used, the incremental returns would be similar to those achieved in a traditional glass greenhouse.

8. The total incremental costs per square foot would be $0.67 in a greenhouse and $0.72 in a heated plastic tunnel.

Based on the above assumptions, we have conducted a preliminary economic analysis of the incremental returns to the grower from radish production in traditional greenhouses and plastic tunnels. Our findings are summarized below:

INCREMENTAL RETURN TO GROWER
FOR RADISH PRODUCTION
PER SQUARE FOOT
(Growing period from November to March)

	Greenhouse	Plastic Tunnels
Yield (bunches)	3.0	3.0
Revenues	$ 0.65	$ 0.65
Costs	0.67	0.72
Return to Grower	$ (0.02)	$ (0.07)

As shown above, the return to the grower from the production of radishes in both greenhouses and plastic tunnels appears to be marginal.

TABLE 16

WHOLESALE UNLOADS OF SPINACH
1979 - 1983
('000 lbs.)

	1983	1982	1981	1980	1979
B.C.	4,444	4,160	4,020	3,491	2,442
Prairie Provinces	2,648	1,702	1,438	819	503
Western Canada	7,092	5,862	5,458	4,310	2,945

Source: Annual Unload Report Fresh Fruits and Vegetables
Agriculture Canada, 1979 - 1983

VII. SPINACH

Our observations and findings regarding spinach as an alternative greenhouse crop are provided in the following sections.

A. MARKET CHARACTERISTICS

1. The total volume of spinach sold to wholesalers in Western Canada in 1983 was 7,092,000 pounds.

2. As shown in Table 16, B.C. is the largest consumer of spinach. The volume of spinach sold to B.C. wholesalers accounted for 62.6% of the total quantity of spinach distributed in Western Canada in 1983.

3. Growth in the consumption of spinach in Western Canada has been dramatic. Between 1979 and 1983, the volume of spinach sold in the Prairie provinces increased by an average of 51.4% per year which was considerably higher than the average growth rate of 16% per year experienced in B.C.

4. As shown in Table 17, California is the major supplier of spinach to Western Canada. In 1983, California supplied a total of 4,183,000 pounds or 58% of the total volume of spinach sold in Western Canada. The other major supplier of spinach is Texas which accounted for 18% of the total market.

5. Approximately 781,000 pounds of local spinach was sold in B.C. which accounted for 18% of the B.C. market. The market share held by B.C. field growers in the Prairie provinces, however, was only 5%.

6. As shown in Table 18, B.C. field spinach is available from April to November. The market share held by B.C. field spinach growers increases to only about 55% at the height of the season in June. As a result, the B.C. wholesalers must rely heavily on imported product even during the summer months.

TABLE 17

SOURCES OF SUPPLY OF SPINACH
IN 1983
('000 lbs.)

	B.C.	Prairie Provinces	Total
Domestic:			
B.C.	781	142	923
Alberta	-	-	-
Saskatchewan	-	-	-
Manitoba	-	-	-
Other	-	49	49
Total	781	191	972
Imports:			
California	1,734	2,449	4,183
Texas	1,220	5	1,225
Other U.S.	709	3	712
Total	3,663	2,457	6,120
TOTAL	4,444	2,648	7,092

Source: Annual Unload Report Fresh Fruits and Vegetables
Agriculture Canada, 1979 - 1983

7. As shown in Table 18, the price of spinach remains quite stable throughout the entire year. This price stability is due to the fact that there are a number of competing sources of supply throughout the year.

B. MARKETING OPPORTUNITIES

Our observations regarding the market potential for B.C. grown spinach are as follows:

1. The demand for spinach in the Prairies is projected to contine to increase substantially by about 25% per year over the next three years. The rate of growth in B.C., however, is likely to be about 8% to 10% per year.

2. The representatives of the wholesale trade that we contacted noted that the quality of spinach available from Texas and California was satisfactory. They did indicate, however, that they would be willing to purchase spinach produced in B.C. greenhouses as it would likely be fresher than the imported product. The fine leaf spinach varieties are in greater demand than the coarser types of spinach.

3. The major marketing opportunity, therefore, is to supply spinach to the Western Canada market during the period from November to April. There also exists an opportunity to supply greenhouse spinach during the balance of the year as the local field production is not sufficient to supply total market needs even during the summer months. It is unlikely, however, that the greenhouse product could obtain a premium in the price paid for local field grown spinach or the imported field grown products.

C. PRODUCTION

Spinach is considered to be a "cool" crop and could quite easily be grown in unheated plastic tunnels most of the year. Supplemental heat might be necessary only in extreme cold conditions.

TABLE 18

SPINACH MONTHLY UNLOADS
IN B.C. IN 1983
('000 lbs.)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
B.C.	-	-	-	15	168	192	96	125	123	51	11	-	781
Other Domestic	-	-	-	-	-	-	-	-	-	-	-	-	-
California	210	216	213	231	173	108	40	54	21	101	151	216	1,734
Other Imports	182	213	268	214	39	19	-	-	-	-	118	167	1,220
	392	429	481	488	425	351	209	329	238	284	420	398	4,444
Avg Price Per .83 pound	$ .39	$ .44	$ .48	$ .50	$ .42	$ .42	$ .38	$ .37	$ .38	$ .38	$ .36	$ .42	$ .41

Sources: BCMA Marketing Branch
Annual Unload Report Fresh Fruits and Vegetables
Agriculture Canada 1983

Most varieties of spinach do not tolerate large amounts of intense sunlight. As a result, yields in the summer months would likely be less than in the spring and fall. Research recently undertaken at the Agassiz Research Station indicated that spinach could be successfully grown in the spring and fall in unheated plastic tunnels. Depending on the variety planted, spinach will require 50 to 70 days from seeding to harvest. As a result, it would be possible to obtain up to seven crops per year. Approximately one bunch weighing 12 ounces can be harvested per square foot for each crop planted.

D. ECONOMIC VIABILITY

Based on our discussions with producers and government representatives, we have conducted a preliminary analysis of the economic potential for producing spinach in B.C. greenhouses and unheated plastic tunnels. The key assumptions that we have used are summarized below:

1. Production of spinach would be undertaken on a year round basis.

2. The costs per square foot for production in conventional greenhouses are estimated to be $3.17. The estimated costs per square foot of producing in plastic tunnels are $2.03.

3. The average revenue received for a 12 ounce bunch of spinach is estimated to be $0.41.

4. The yield per crop in greenhouses is estimated to be 10.8 ounces or 0.9 bunches per square foot. A total of seven crops per year would be harvested.

5. The yield per crop in plastic tunnels is estimated to be the same as in a greenhouse but the number of crops harvested would be less. This reduction in the number of crops is due to the longer growing times in the winter in unheated plastic tunnels. The number of crops obtained in plastic tunnels, therefore, is estimated to be six per year.

Based on the above assumptions, the return to the grower for spinach production in greenhouses and plastic tunnels is estimated to be as follows:

RETURN TO GROWER
FOR SPINACH PRODUCTION
(PER SQUARE FOOT)

	Greenhouse	Plastic Tunnels (unheated)
Yield (bunches)	6.3	5.4
Revenues	$ 2.58	$ 2.21
Costs	3.17	2.03
Return to Grower	$ (0.59)	$ 0.18

As shown above, the production of spinach appears most feasible in plastic tunnels. Based on the available information, the return to grower that could be obtained is estimated to be about $0.18 per square foot in unheated plastic tunnels.

TABLE 19

WHOLESALE UNLOADS OF ZUCCHINI
1979 - 1983
('000 lbs.)

	1983	1982	1981	1980	1979
B.C.	2,226	1,724	1,617	257	Data Not Available
Prairie Provinces	2,776	2,378	2,068	1,972	Data Not Available
Western Canada	5,002	4,102	3,685	2,229	

Source: Annual Unload Report Fresh Fruits and Vegetables
Agriculture Canada, 1979 - 1983

VIII. ZUCCHINI

This chapter contains our observations and findings regarding the marketing opportunities and production constraints of growing zucchini as an alternative greenhouse crop.

A. MARKET CHARACTERISTICS

1. As shown in Table 19, a total of 5,002,000 pounds of zucchini were sold in 1983 to wholesalers in Western Canada.

2. Between 1983 and 1981, sales of zucchini in Western Canada grew at an average rate of 10.7% per year. Sales in British Columbia increased by 11.2% per year, while in the Prairie provinces, the quantity of zucchini sold grew by an average rate of 10.3% per year.

3. As shown in Table 20, 87% of the zucchini sold in 1983 in Western Canada was imported. The major supplier of zucchini to Western Canadian wholesalers was Mexico which shipped 2,405,000 pounds or 48% of the total zucchini sold. The other major supplier was the United States which accounted for 39% of the Western Canada market.

4. B.C. field producers supplied 17.5% of all zucchini purchased by B.C. wholesalers. Domestic field grown product accounted for 9.5% of the volume of zucchini distributed through wholesalers in the Prairie provinces.

5. As shown in Table 21, local field grown zucchini was available in B.C. between the months of July to September in 1983. During this period, the B.C. product accounted for about three-quarters of the total zucchini sold.

TABLE 20

SOURCES OF SUPPLY OF ZUCCHINI IN 1983 ('000 pounds)

	B.C.	Prairie Provinces	Total
Domestic			
B.C.	390	-	390
Alberta	-	-	-
Saskatchewan	-	-	-
Manitoba	-	-	-
Other	-	264	264
Total	390	264	654
Imports			
Other U.S.	628	1,315	1,943
Mexico	1,208	1,197	2,405
Total	1,836	2,512	4,348
TOTAL	2,226	2,776	5,002

Source: Annual Unload Report Fresh Fruits and Vegetables, Agriculture Canada 1983.

6. The average yearly landed cost to B.C. wholesalers for a pound of zucchini in 1983 was $0.42. During the period from July to September when local product is available, the market price ranged from $0.16 to $0.25 per pound. For the balance of the year, however, when imported product was only available, the price of zucchini increased significantly to a level of $0.56 to $0.60 per pound.

B. MARKET OPPORTUNITIES

Our observations regarding the market opportunities for zucchini are as follows:

1. Zucchini sales are projected to increase by 10% per year over the next three years.

2. According to the wholesalers contacted, zucchini is available in sufficient quantities during the majority of the year. However, during the months from November to January, the quality of zucchini imported from Mexico is of only fair quality.

3. The wholesalers expressed a willingness to purchase local greenhouse grown zucchini if the product was priced competitively with imports.

4. There exists an opportunity, therefore, for greenhouse growers to supply the B.C. and Prairie markets for appoximately nine months of the year when the local field product is not available.

C. PRODUCTION

Zucchini is considered to be a "warm" crop. The optimal day temperature for growing zucchini is between 72° F. and 79° F. while ideal night temperatures range between 46° F and 66° F.

There are separate male and female flowers on zucchini plants which require that pollination must be performed manually or with the use of bees. To ensure that fruit development continues throughout the life of a plant, picking of ripe fruit should be undertaken daily.

TABLE 21

ZUCCHINI MONTHLY UNLOADS
B.C.
('000 lbs.)
1983

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
B.C.	-	-	-	-	-	-	-	-	-	-	-	-	-
Other Domestic	-	-	-	-	-	-	58	179	153	-	-	-	390
Mexico	285	206	169	213	95	-	3	-	-	-	70	167	1,208
Other Imports	-	-	-	-	-	140	113	51	60	100	164	-	628
	285	206	169	213	95	140	174	230	213	100	234	167	2,226
Avg Price Per Pound	$ .68	$ .53	$ .43	$ .53	$ .41	$ .32	$ .25	$ .16	$ .21	$ .52	$ .51	$ .50	$ .42

Sources: BCMA Marketing Branch
Annual Unload Report Fresh Fruits and Vegetables
Agriculture Canada 1983

Zucchini requires approximately five weeks from transplanting to harvest. The harvest period can extend four to five months. One of the potential constraints of growing zucchini in the winter months is that there is insufficient sunlight to permit flowering to occur. According to the industry representatives contacted, the latest a fall crop should be planted is in mid-August. Another crop could then be planted in mid-February, resulting in a potential of two crops per year. The potential yield per crop is estimated to be about 3 pounds per square foot.

Commercial production of zucchini in greenhouses has not been undertaken successfully in Western Canada. Research trials are currently being conducted in growing zucchini as a fall crop in large plastic tunnels. The results of these trials, however, have not yet been evaluated.

D. ECONOMIC VIABILITY

Our major assumptions to assess the viability of zucchini as an alternative greenhouse crop are as follows:

1. Production would be undertaken on a year round basis.

2. The harvest season would extend from October to June when local product is not available.

3. The average revenue received would be $0.52 per pound.

4. Total production costs are estimated to be $3.63 per square foot in a greenhouse and $3.24 in a heated plastic tunnel.

5. The yield obtained in heated plastic tunnels is likely to be only two thirds of the productivity in a traditional greenhouse.

Based on these assumptions, the net return to the grower from producing zucchini in traditional greenhouses and plastic tunnels is as follows:

RETURN TO GROWER
FOR ZUCCHINI PRODUCTION
(PER SQUARE FOOT)

	Greenhouse	Plastic Tunnels
Yield (pounds)	6.0	4.0
Revenues	$ 3.12	$ 2.08
Costs	3.63	3.24
Return to Grower	$ (0.51)	$ (1.16)

Based on the preliminary analysis shown above, year round production of zucchini does not appear viable in either heated plastic tunnels or traditional greenhouses.

TABLE 22

WHOLESALE UNLOADS OF GREEN ONIONS
1979 - 1983
('000 lbs.)

	1983	1982	1981	1980	1979
B.C.	5,066	5,024	4,978	4,826	4,497
Prairie Provinces	8,880	8,512	8,915	8,173	6,885
Total Western Canada	13,946	13,536	13,893	12,999	11,382

Source: Annual Unload Report Fresh Fruits and Vegetables
Agriculture Canada, 1979 - 1983

IX. GREEN ONIONS

Our major observations and findings regarding green onions as an alternative crop for B.C. greenhouses are as follows:

A. MARKET CHARACTERISTICS

1. As shown in Table 22, the total volume of green onions sold in Western Canada in 1983 was 13,946,000 pounds.

2. The consumption of green onions in Western Canada has increased at an average annual rate of 5% per year over the last four years. The growth rate in the Prairies averaged 6% per year which was twice the rate of growth in B.C.

3. As shown in Table 23, the major supplier of green onions to the B.C. market is California. In 1983, California growers exported a total of 2,693,000 pounds of green onions to B.C. which constituted 73% of the total B.C. market. The remainder of the B.C. market was supplied primarily by domestic field producers in B.C.

4. The major suppliers of green onions to the Prairies are California and Mexico which accounted for a 51% and 29% of the total market, respectively. The major domestic supplier of green onions to the Prairies is Manitoba which supplied a total of 899,000 pounds or 10% of the Prairie market.

5. As shown in Table 24, domestic field grown onions are available primarily from May to October in B.C. During this period in 1983, domestic producers obtained up to 69% of the total volume of green onions sold in B.C. The green onions consumed during the balance of the year were imported primarily from California and Mexico.

6. As shown in Table 24, the price of green onions remained relatively constant throughout 1983.

TABLE 23

SOURCES OF SUPPLY OF GREEN ONIONS
IN 1983
('000 lbs.)

	B.C.	Prairie Provinces	Total
Domestic:			
B.C.	1,365	49	1,414
Alberta	-	-	-
Saskatchewan	-	-	-
Manitoba	-	899	899
Other	-	94	94
Total	1,365	1,042	2,407
Imports:			
California	3,693	4,502	8,195
Other	2	728	730
Mexico	6	2,578	2,584
Total	3,701	7,808	11,539
TOTAL	5,066	8,880	13,946

Source: Annual Unload Report Fresh Fruits and Vegetables
Agriculture Canada, 1979 - 1983

B. MARKETING OPPORTUNITIES

1. The wholesalers indicated that the demand for green onions is unlikely to increase substantially in the next three years. The anticipated rate of growth is approximately 1% to 2% per annum.

2. The wholesalers interviewed indicated that they are satisfied with the quality and consistency of green onions currently available. They expressed a willingness, however, to procure green onions from local greenhouse growers when domestic field grown product is not in season. This period usually extends from November to April.

3. Since the quality of green onions currently available is excellent, a greenhouse grown product would be unlikely to command a premium price.

4. The major marketing opportunities for greenhouse growers are to produce green onions for the B.C. and Prairie markets during the months from November to April.

C. PRODUCTION

Green onions are considered to be a "cool" crop. The time required from seeding to harvest averages approximately 60 days. To date, green onions have not been produced in greenhouses on a sustained commercial basis in Western Canada.

According to the industry representatives contacted, a crop of green onions produced in a traditional greenhouse can yield up to 1.2 bunches per square foot. The growing time required in a heated greenhouse may be lengthened in the winter months as a result of lower light intensity.

TABLE 24

MONTHLY UNLOADS OF GREEN ONIONS IN B.C. IN 1983 ('000 lbs.)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
B.C.	-	-	-	-	84	394	324	264	271	28	-	-	3,693
Other Domestic	-	-	-	-	-	-	-	-	-	-	-	-	-
California	452	423	479	454	431	120	13	118	68	264	548	323	1,365
Mexico	-	-	-	-	-	-	-	-	-	-	6	-	6
Other Imports	-	-	-	-	-	-	-	2	-	-	-	-	2
	452	423	479	454	515	514	337	384	339	292	554	323	5,066
Avg Price Per Bunch	$ .20	$ .18	$ .18	$ .19	$ .19	$ .17	$ .17	$ .17	$ .17	$ .17	$ .22	$ .21	$ .18

Sources: BCMA Marketing Branch
Annual Unload Report Fresh Fruits and Vegetables
Agriculture Canada 1983

According to the information obtained from producers and other industry representatives, we have conducted a preliminary analysis of the viability of producing green onions in heated plastic tunnels and traditional greenhouses in the winter months. The key assumptions that we have used are as follows:

1. Production would be geared towards harvesting in the months from December to April.

2. Harvesting would be performed manually.

3. The first crop could be planted in October and harvested in December. A second crop could be planted in December and be ready for harvest in February while the third crop would be planted in February and harvested in April.

4. The yield for each crop would be 1.2 bunches per square foot in both heated plastic tunnels and greenhouses.

5. The average revenue received by the grower during this period would be $.195 per bunch.

6. The incremental costs would include heating, direct operating and marketing expenses. The costs per square foot in a plastic tunnel would be higher because of a greater heat loss than in a traditional greenhouse. The total incremental costs per square foot in the greenhouse are estimated to be $0.75 and while in a plastic tunnel, the incremental costs total $0.82.

Based on the above assumptions, the incremental return to the grower from green onion production would be as follows:

INCREMENTAL RETURN TO GROWER
FOR GREEN ONION PRODUCTION
PER SQUARE FOOT
(Growing period from December to April)

	Greenhouse	Plastic Tunnels
Yield (bunch)	3.6	3.6
Revenues	$ 0.70	$ 0.70
Costs	$ 0.75	$ 0.82
Return to Grower	$ (0.05)	$ (0.12)

As shown above, the returns to the grower are marginal from the production of green onions in both a traditional greenhouse and plastic tunnels.

TABLE 25

POTENTIAL GREENHOUSE CROPS THAT COULD BE PRODUCED ON A YEAR ROUND BASIS

Vegetable	Production[2] Method	Net Incremental Return to Grower[2] (per square foot)	Potential[1] Market (pounds)	Greenhouse[3] Space Required (square feet)
Green Beans	Greenhouse	$0.14	1,384,000	58,000
Fancy Peppers	Greenhouse	$0.30	91,000	6,000
Spinach	Unheated plastic tunnel	$0.18	3,663,000	204,000
TOTAL			5,138,000	268,000

1. Based on total volume of vegetables imported into B.C. in 1983.
2. We have not included Chinese cabbage and zucchini as our analysis indicates that the return from these crops would be negative.
3. Based on obtaining a 25% market share of volume vegetables currently imported into B.C.

X. CONCLUSIONS AND RECOMMENDATIONS

Our conclusions and recommendations regarding the viability of producing alternative crops in B.C. greenhouses are provided in the following paragraphs.

A. CONCLUSIONS

Based on our market research, we have identified five vegetables which could be produced in local greenhouses on a year round basis in B.C. to replace the product currently imported into Western Canada. These vegetables are Chinese cabbage, green beans, fancy peppers, spinach and zucchini. Based on the production information available, however, only three of these crops, green beans, fancy peppers and spinach, would appear to be economically viable. Our economic analysis, however, is based on estimated costs only as there exists a lack of information on the actual yields and likely production and marketing costs that would be incurred if these vegetables were grown in B.C. greenhouses. In addition, the scope of the study did not permit a detailed five year analysis of the prices obtained for each commodity.

The most appropriate type of facility for the production of spinach would be unheated plastic tunnels as spinach tolerates cool temperatures. Green beans and fancy peppers, however, would best be produced in traditional greenhouses as they are considered to be warm crops.

As an illustration of the market potential, the total volume of green beans, fancy peppers (imported from Holland) and spinach imported into B.C. in 1983 is provided in Table 25. If B.C. producers were able to achieve 25% share of this market, the total amount of greenhouse space that would be required to supply this volume of product would be approximately 268,000 square feet.

As part of our market research, we have also identified a number of vegetables which could be produced in the months when local field grown product is not available and the market must rely entirely on imported product. These vegetables are green onions, fancy lettuce and radishes. Based on the available production information, the production of fancy lettuce appears to be the most viable while green onions and radishes are more marginal. Table 26 provides an

TABLE 26

SUPPLEMENTAL GREENHOUSE CROPS

	Production Method	Net Incremental Return to Grower[2] (per square foot)	Potential[1] Market (pounds)	Greenhoused[2] Space Required (square foot)
Green Onions	Greenhouse	$(0.05)	2,685,000	691,000
Lettuce				
Romaine	Unheated tunnel	$ 0.55	256,000	35,000
Leaf	Greenhouse	$ 1.23	277,000	19,000
Endive	Greenhouse	$ 0.55	230,000	23,000
Radishes	Greenhouse	(0.02)	956,000	109,000
			4,404,000	877,000

Notes:

1. Based on imports into B.C. during period when local field product is not in season.
2. Based on a 25% market share.

indication of the volume of these products imported into B.C. The amount of greenhouse space that would be required to displace 25% of the imports of these three vegetables is a total of 877,000 square feet. All of these crops, except romaine lettuce, would best be produced in traditional greenhouses rather than unheated plastic tunnels.

Though the most immediate market opportunity is to reach the local market, there also exists potential to supply the products listed above to the Prairies. As shown in the previous chapters, the Prairie markets are even more dependent than B.C. on imported products. To obtain a significant share of the market, it would be necessary for B.C. producers to supply greenhouse products of a comparable quality and price to the imported products.

B. RECOMMENDATIONS

Our recommendations regarding the alternative greenhouse crops that could be produced in B.C. are as follows:

1. Extensive production trials should be conducted for the more promising crops that have been identified to have market potential.

   The crops to be included in these trials are green beans, fancy peppers, spinach, lettuce, green onions, and radishes. While some research has already been undertaken regarding these crops, more extensive investigation is required to determine the likely yields and feasibility of producing these vegetables, especially in the winter months.

2. Based on the results of the production trials, a detailed analysis of the likely production costs for each vegetable should be undertaken.

   This information should then be used to assess the feasibility of producing the greenhouse crops that have been identified to have market potential. The feasibility analysis should also include a more detailed review of the likely prices to be obtained for each product.

3. A detailed investigation of the prices obtained by growers over the last five years should be conducted for the most promising crops. In addition, analysis of the expected future prices should be undertaken for each commodity that appears to have potential.

   This pricing information can be used in conjunction with refined production and marketing cost information to assess the potential profitability of each crop. Growers should undertake a profitability analysis for each crop based on the particular cost structure that exists in their respective operations.

4. The major marketing opportunity that should be pursued is to supply the B.C. market. The specific crops that appear promising for year round production are green beans, fancy peppers and spinach. The vegetables which would be grown as supplemental crops include fancy lettuce, green onions and radishes.

5. The other market opportunity is to service the Prairie market which relies heavily on products imported from the United States and Mexico.

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APPENDIX I
PRODUCTION COST ASSUMPTIONS FOR ALTERNATIVE GREENHOUSE CROPS

APPENDIX I

COST ASSUMPTIONS

The costs used in this study are only estimates and growers should assess potential profitability from each crop by comparing projected revenues with their specific costs. This Appendix is intend to serve as a guideline in the analysis of profitability.

A. YEAR ROUND PRODUCTION

The costs per square foot used in our analysis of the potential returns for the alternative crops which have market potential for year round production are comprised of 3 components which are described in the followed paragraphs. The three components are as follows:

1. Fixed costs
2. Marketing costs
3. Operating costs

The cost estimates shown in the following paragraphs are also based on soil rather than hydroponic production.

1. Fixed Costs:

Greenhouses

a. The fixed costs per square foot were extracted from the Cost of Production (COP) model for greenhouse tomatoes produced by the B.C. Ministry of Agriculture and Food. Based on this model, the fixed costs are shown to be $1.48 per square foot per annum.

b. The fixed costs in the COP model include depreciation, return on investment, land rental and owner/operator wages.

Plastic Tunnels

c. Appendix 2 provides a breakdown of the calculations of the fixed costs per square foot used in the assessment of the economic returns with plastic tunnel production. As shown in Appendix 2, the fixed costs per square foot are estimated to be 92¢ per square foot per year.

2. Marketing Costs

a. Based on our interviews with producers, we estimate that the costs of packaging and delivering products to market are approximately 30¢ per square foot per year. These costs are estimates only and each grower would have to identify his particular cost structure for further analysis.

3. Operating Costs

Greenhouses

a. A detailed breakdown of direct operating costs are provided in Table A on the opposite page for year round crops. As indicated, this component includes culturing costs and cash costs such as labour, heat and insurance.

b. The operating costs for each alternative crop are based on information provided by producers and Mr. Brian Mauza of the B.C. Ministry of Agriculture and Food. Each crop's needs for heat and labour were compared to those of tomatoes and cucumbers. As an example, peppers were estimated to require only one-half the labour input of tomatoes. Therefore, we used only half the direct labour costs in the COP model in determining the operating costs for peppers.

c. The harvesting of the crops would be undertaken manually as no provision for automated harvesting equipment is provided.

TABLE A

DIRECT OPERATING EXPENSES PER CROP - YEAR ROUND CROPS

GREENHOUSES

Direct Costs	Chinese Cabbage	Green Beans	Zucchini	Peppers	Spinach
Heat	.40	.93	.86	.93	.40
Labour	.68	.96	.42	.42	.42
Fertilizer	.08	.08	.08	.08	.08
Seed, Vehicle Fuel, Electricity	.06	.06	.06	.06	.06
Insurance, Interest on working capital	.38	.38	.38	.38	.38
Cash overhead	.05	.05	.05	.05	.05
Total	$ 1.65	$2.46	$1.85	$1.92	$1.39

PLASTIC TUNNELS

Direct Costs	Chinese Cabbage (unheated)	Green Beans (heated)	Zucchini (heated)	Peppers	Spinach (unheated)
Heat	-	1.11	.103	-	-
Labour	.54	.84	.42	-	.54
Fertilizer	.08	.08	.08	-	.08
Seed, Vehicle Fuel, Electricity	.06	.06	.06	-	.06
Insurance, Interest on working capital	.28	.28	.28	-	.28
Cash overhead	.05	.05	.05	-	.05
Total	$ 1.01	$2.42	$1.92	-	$ .81

INCREMENTAL COSTS - SUPPLEMENTAL CROPS

	Greenhouse			Plastic Tunnels
Direct Costs	Green Onions	Radishes	Leaf & Endive Lettuce	Romaine Lettuce
Heat	.32	.27	.29	-
Labour	.31	.33	.42	.35
Fertilizer	.01	.01	.01	.01
Seed, Vehicle Fuel, Electricity	.01	.01	.01	.01
Insurance, interest on working capital	-	-	-	-
Marketing Expenses[1]	.08	.05	.05	.05
Total	$ .75	$ .67	$ .78	$ .42

Notes: 1. Marketing costs are charged only for the months of harvest for the supplemental crops.
2. Each crop's needs for heat and labour requirements were assessed relative to the needs of greenhouse tomatoes and cucumbers.

Sources: Based on discussions with producers and Mr. Brian Mauza, Cost of Production Models for greenhouse cucumbers and tomatoes.

Plastic Tunnels

d. For the evaluation of potential returns from plastic tunnel production, we classified the crops into two categories according to their temperature requirements. Beans, zucchini and peppers are considered to be warm crops, while the remainder are cool crops.

e. For the warm crops, we assumed that heating would be required in the plastic tunnels while no provision for heat was included in estimated production costs for cool crops.

B. SUPPLEMENTAL CROPS

For those crops identified to have market potential for production in the off season, we conducted an analysis of the incremental returns that a grower could realize. The estimated incremental costs for producing each crop are also provided in Table A on the previous page. The incremental costs used in our analysis included only the additional direct operating, heating and marketing expenses that would be incurred by using the greenhouse or plastic tunnel during the months when local field production is unavailable. Implicit in this analysis is that the fixed costs of the facility, including the owner's wages, have already been recovered by the production of other crops during the balance of the year.

APPENDIX 2
ESTIMATED FIXED COSTS OF LARGE PLASTIC TUNNELS

APPENDIX 2

ESTIMATED FIXED COSTS FOR SINGLE-POLY PLASTIC TUNNELS

(Based on 50,000 ft^2 of greenhouse space)

Capital Costs	Estimated Life	Cost	Depreciation (Annual) Per Year Cost	(per square foot)
1. Plastic materials @ ($.45/$ft^2$)	3	$22,500	$ 7,500	$.15
2. Frame and installation @ ($.60/$ft^2$)	10	30,000	3,000	.06
3. Equipment (as per tomato[1] cost model, excluding computer)	10	46,140	4,614	.09
4. Large fan (2)	5	1,200	240	.01
5. Irrigation system, wiring, roads, etc. depending on item	10-20	58,600	3,700	.07
		$158,440	$19,054	$.38

Total Fixed Costs		
1. Return on investment (3.7%)	$ 5,031	
2. Owner/Operator Labour	21,000	
3. Land rental (5 acres @ $144/acre)	720	
	$26,751	$.54
4. Depreciation (as above)		.38
		$.92

Note:

1. Equipment costs may vary with different crops and between growers.